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(54) Water-decomposable non-woven fabric.

(57) A water-decomposable non-woven fabric comprises a water-dispersible fiber layer, each fiber of which is bound with one another using a water-soluble binder comprising an unsaturated carboxylic acid/unsaturated carboxylic acid ester copolymer in which 1 to 60 mole % of the repeating units derived from the unsaturated carboxylic acid is in the form of a salt and which is soluble in tap water but is insoluble in an aqueous solution containing not less than 0.5 % by weight of a neutral inorganic salt comprising a monovalent ion; the water-dispersible fiber layer being composed of a mixture of 40 to 90 % by weight of fibers having a crimp number of 19/inch or less, 10 to 60 % by weight of fibers having a crimp number of 20/inch to 25/inch, and not more than 10 % by weight of fibers having a crimp number of 26/inch or more; and a content of the binder in the non-woven fabric being 1 to 30 % by weight relative to the total weight of the non-woven fabric. The non-woven fabric has a good feeling (high softness and good touch) and sufficient mechanical strength, and can be easily broken and dispersed by throwing into a large amount of water.

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The present invention relates to a water-decomposable non-woven fabric which can be easily broken and dispersed by throwing into a large amount of water.

Non-woven fabrics have been widely used as a material for disposable absorbent articles such as sanitary napkins and paper diapers.

The non-woven fabrics used for the absorbent articles must have a toughness sufficient for resisting to breakage when they are wetted with a body fluid such as the menstrual blood or urine. Therefore, water-insoluble resins are generally used as a binder to bind fibers.

On the other hand, it is required of the non-woven fabrics to be used for the disposable absorbent articles or diaper liners that they can be brought into fine pieces and dispersed in water (water-decomposability) so that they can be thrown into a flush toilet. The above-described non-woven fabrics using water-insoluble resins as a binder are, therefore, unsatisfactory in view of these uses.

So far several proposals have been made on the water-decomposable non-woven fabric. For example, Japanese Patent Unexamined Published Application (hereinafter referred to as "J.P. KOKAI" No. Hei 1-306661 discloses a water-decomposable non-woven fabric composing a water-decomposable fabric layer, each of faber of which is bound with one another using a water-soluble binder mainly containing an unsaturated carboxylic acid/unsaturated carboxylic acid ester copolymer in which a part of the unsaturated carboxylic acid is neutralized to form a salt. In this case, a fiber web is prepared from viscose rayon fibers having a length of 26 mm and a size of 2 denier by airlay method. However, since the viscose rayon fibers employed are of ordinal crimp numbers, i.e., not more than 19/inch, the resulting water-decomposable non-woven fabric has weak mechanical strength. The content of binder in the non-woven fabric was increased in order to increase the mechanical strength, but the resulting non-woven fabric became hard and sufficient mechanical strength could not be obtained, which properties were still unsatisfactory in the practical view points.

A primary object of the present invention is to provide a non-woven fabric having a good feeling (high softness and good touch), sufficient mechanical strength and water-decomposability by which the above-described problems in the prior art have been solved.

This and other objects of the present invention will be apparent from the following description and Examples.

The above-described problems can be solved by using a mixture of specific crimped fibres as a fabric layer of which non-woven fabric is composed.

Namely, the present invention provides a water-decomposable non-woven fabric comprising a water-dispersible fiber layer, each fiber of which is bound with one another using a water-soluble binder comprising an unsaturated carboxylic acid/unsaturated carboxylic acid ester copolymer in which 1 to 60 mole % of the repeating units derived from the unsaturated carboxylic acid is in the form of a salt and which is soluble in tap water but is insoluble in an aqueous solution containing not less than 0.5 % by weight of a neutral inorganic salt comprising a monovalent ion; the water-dispersible fiber layer being composed of a mixture of 40 to 90 % by weight of fibers having a crimp number of 19/inch or less, 10 to 60 % by weight of fibers having a crimp number of 20/inch to 25/inch, and not more than 10 % by weight of fibers having a crimp number of 26/inch or more; and the content of the binder in the non-woven fabric being 1 to 30 % by weight relative to the total weight of the non-woven fabric.

As fibers which compose the water-dispersible fiber layer (also referred to as web), there can be used conventional ones such as natural fibers (e.g. cotton, flex, jute, cotton linter and wooden pulp), regenerated cellulose fibers (e.g. rayon and cupro-ammonium rayon), modified cellulose fibers (e.g. cellulose acetate) and synthetic fibers (e.g. polyvinylalcohol, polyesters, polyamides and polyolefins). Although these fibers can be used singly or in combination, it is advantageous to use natural fibers or cellulose fibers in view of their biodegradability.

The web used in the present invention consists of a mixture of crimped fibers having a length of not longer than 30 mm. In this connection, the length of the fiber means a length when the crimped fiber is stretched in straight line. In other words, the length indicates a length of fiber which has not been crimped. The mixture comprises 40 to 90 % by weight of fibers having a crimp number of 19/inch or less, 10 to 60 % by weight of fibers having a crimp number of 20/inch to 25/inch, and not more than 10 % by weight of fibers having a crimp number of 26/inch or more, preferably 60 to 70 % by weight of fibers having a crimp number of 19/inch or less, 30 to 40 % by weight of fibers having a crimp number of 20/inch to 25/inch, and not more than 5 % by weight of fibers having a crimp number of 26/inch or more.

The crimped fibers can be easily prepared by a conventional method and the crimp number thereof can be easily arranged to appropriate numbers by controlling the condition of the preparation. For example, the fibers such as modified cellulose fibers and synthetic fibers can be mechanically crimped by a crimper and the crimp number can be controlled by changing the pressure of the crimper. Further, regarding

regenerated cellulose fibers such as rayon, structural anisotropy is given to fibers in the direction of the size (width) of the fiber at spinning, cut into short fibers having a certain length, and heated so as to crimp the fibers due to the difference in the heat shrinkage. In this respect, the crimp number can be controlled by changing the structural anisotropy and heating condition such as a temperature and time period.

Where fibers having a length of longer than 30 mm are used and the resulting non-woven fabric is water-decomposed in water, there is observed phenomena in which so-called twined rope is formed by twisting the released fibers with one another. The resulting rope of fibers is of worse flowability and it is difficult to dispose it through a flush toilet. Therefore, it is preferable that the length of fibers used in the present invention be not longer than 30 mm, more preferably not longer than 20 mm. On the other hand, it is preferable that the length of fibers be not shorter than 5 mm in view of the preparation of the web.

The maximum crimp number of fibers is preferably not more than 30/inch. Where the crimp number is over 30/inch, it tends to easily form a rope of fibers. The minimum crimp number of fibers is preferably not less than 5/inch. Where the crimp number is less than 5/inch the mechanical strength of the resulting web lowers. It is further preferable to use a mixture of 40 to 90 % by weight of fibers having a crimp number of 5/inch to 19/inch and 10 to 60 % by weight of fibers having a crimp number of 20/inch to 25/inch.

The web can be prepared by either so-called wet method according to wet paper-making method or so-called dry method according to airlay method or carding method, but the wet method is preferable in view of the resulting web having high softness and good touch. In this connection, the web can be easily prepared even by a conventional carding method (dry method) since the present invention uses a mixture of the fibers comprising, as a main ingredient, crimped fibers having a crimp number of not more than 25/inch. It is generally believed that it is difficult to prepare a web by a carding method using short fibers of a length of not longer than 30 mm, but the web can be easily prepared from the fibers since the fibers have specific crimp number. The web used as a raw material in the present invention is preferably subjected to water-needling treatment. In this respect, since the specific crimped fibers are used, the water-needling treatment can be easily conducted even under a water pressure of 60 kg/cm^2 or lower and non-woven fabric having high softness and good touch can be prepared.

The binders usable in the invention to bind fibers are water-soluble unsaturated carboxylic acid/unsaturated carboxylic acid ester copolymers in which a part of the unsaturated carboxylic acid is neutralized to form a salt and which are soluble in tap water but are insoluble in an aqueous solution containing not less than 0.5 % by weight of a neutral inorganic salt comprising a monovlent ion such as NaCl, KCl or NaBr. Although conventional unsaturated carboxylic acids can be used as a monomer component of the copolymers, acrylic acid and/or methacrylic acid are preferable. Examples of the unsaturated carboxylic acid ester monomer components include acrylic esters and/or methacrylic esters having an alkyl group of 1 to 18 carbon atoms or a cycloalkyl group of 3 to 18 carbon atoms and it is preferable that acrylic esters and/or methacrylic esters having an alkyl group of 1 to 12 carbon atoms or a cycloalkyl groups of 3 to 12 carbon atoms be used singly or in combination.

More specifically, examples of the copolymers include copolymers of 10 to 90%, preferably 20 to 70 % by weight of acrylic acid and/or methacrylic acid and 90 to 10%, preferably 80 to 30% by weight of acrylic esters and/or methacrylic esters having an alkyl group of 1 to 18 carbon atoms or a cycloalkyl group of 3 to 18 carbon atoms in which 2 to 60 mole %, preferably 5 to 50 mole % of acrylic acid and/or methacrylic acid is neutralized to form a salt; or copolymers of 30 to 75%, preferably 40 to 65 % by weight of acrylic acid, 5 to 30 %, preferably 10 to 25% by weight of acrylic esters and/or methacrylic esters having an alkyl group of 8 to 12 carbon atoms and 20 to 40 %, preferably 25 to 35 % by weight of acrylic esters and/or methacrylic esters having an alkyl group of 2 to 4 carbon atoms in which 1 to 50 mole %, preferably 2 to 40 mole % of acrylic acid is neutralized to form a salt.

Where the amount of acrylic acid and/or methacrylic acid is larger than the amount mentioned above, strength of the resulting non-woven fabric against body fluids lowers. On the other hand, where the amount of acrylic acid and/or methacrylic acid is smaller than the amount mentioned above, water-solubility of the resulting polymer is reduced. Furthermore, where the neutralized ratio of the unsaturated carboxylic acid is larger than the ratio mentioned above strength of the resulting non-woven fabric against body fluids lowers. Alternatively, where the neutralized ration is smaller than the ratio mentioned above, water-solubility of the resulting polymer is reduced. The molecular weight of the copolymers are not particularly limited, although the weight-average molecular weight of the copolymers is preferably 5,000 to 1,000,000, more preferably 30,000 to 500,000.

Any inorganic base or organic base can be optionally used as a neutralizing agent to neutralize the unsaturated carboxylic acid component of the copolymers. Examples of the neutralizing agents include inorganic bases such as sodium hydroxide, potassium hydroxide, lithium hydroxide and sodium carbonate, and amines such as monoethanolamine, diethanolamine, diethylaminoethanol, ammonia, trimethylamine,

triethylamine, tripropylamine, morpholine. Preferred are ethanolamines or sodium hydroxide or a combination of potassium hydroxide and ethanolamines.

The water-soluble binders mentioned above can be used singly or in combination with an appropriate amount (preferably not more than 20 % by weight relative to total weight of binders) of other water-soluble polymers such as polyvinyl alcohol, polymers of acrylic acid, methacrylic acid or a salt thereof and carboxymethycellulose.

The binder may be used in such that the non-woven fabric contains 1 to 30%, preferably 2 to 20 % by weight of the binder. Where the amount of the binder is less than the amount mentioned above, the resulting non-woven fabric is practically insufficient in view of the mechanical strength. Alternatively, where the amount of the binder is more than the amount mentioned above, the resulting non-woven fabric does not have high softness and good touch.

The binder can be applied to the web by, for example, a spray method, dipping method, printing method or coating method. When the binder is applied to the web, it is possible to uniformly disperse the binder in all area of the web or to disperse in the form of spot. In this respect, it is preferable that some parts in the web remain unbound since the unbound parts work to easily absorb water immersed in the non-woven fabric and to disperse the fabric into each fiber in a short period of time.

Further, absorption and permiability of the non-woven fabric to body fluids can be improved by use of a natural surfactant mild to the skin such as sugar esters, glycerin succinates, alkyl polyglucosides and alkylglycoside acyl esters in combination with the binder at applying the binder to the web.

Although the basis weight of the non-woven fabric of the present invention is not particularly limited, the basis weight is desirably in the range of 15 to 50 g/m^2 which is usually considered to be low.

Even when the non-woven fabric of the present invention is brought into contact with a body fluid such as blood, menstrual blood or urine and wetted with it, the binder is not dissolved therein, since the salt concentration of the body fluid is above the level of dissolution, and the structure of the non-woven fabric is kept to exhibit a toughness and softness satisfactory for the practical use. On the contrary, when the non-woven fabric is brought into contact with water, e.g., tap water, the binder is dissolved, since the salt concentration is reduced to a level low enough for the dissolution of the binder; and the non-woven fabric is easily broken and dispersed in water. Thus the non-woven fabric of the present invention can be disposed through a flush toilet.

The non-woven fabric of the present invention is useful as a surface material or wrapping material for various absorbent articles for absorbing body fluids such as sanitary napkins, sheets for a discharge from the womb, paper diapers and pads for hemorrhoids, or as materials for disposable non-woven fabric products such as bed sheets, toilet sheets for pets and diaper liners which can be disposed through a flush toilet after the use.

The present invention will be illustrated with reference to the following Examples.

Referential Example 1

47 g of acrylic acid, 53 g of cyclohexyl acrylate, 80 g of ethanol and 50 g of distilled water were fed in a 1000 ml four-necked separable flask provided with a stirrer, reflux condenser and nitrogen-introducing tube to obtain a homogeneous solution. Then nitrogen gas was introduced into the flask through the nitrogen-introducing tube under stirring. 20 minutes after, a solution of a polymerization initiator prepared by dissolving 0.25 g of 2,2'-azobis(2,4-dimethylvaleronitrile) in 20 g of ethanol was added to the resultant solution to initiate the polymerization reaction under heating in a water bath maintained at 80 °C. After conducting the polymerization at 80 °C for 6 hours in nitrogen gas stream, the reaction mixture was cooled to room temperature and then neutralized by addition of 24.5 g of 48 wt. % aqueous sodium hydroxide solution and 380 g of distilled water (neutralization rate: 45 molar % based on acrylic acid). The solid content of the resultant polymer solution as determined with a Kett moisture meter was found to be 18.3% and the weight-average molecular weight was 32,000.

Referential Example 2

55 g of acrylic acid, 15 g of 2-ethylhexyl acrylate, 30 g of butyl acrylate, 110 g of acetone and 30 g of distilled water were fed in a 1000 ml four-necked separable flask provided with a stirrer, reflux condenser and nitrogen-introducing tube to obtain a homogeneous solution. Then nitrogen gas was introduced into the flask through the nitrogen-introducing tube under stirring. 20 minutes after, a solution of a polymerization initiator prepared by dissolving 0.88 g of 2,2'-azobis(2-amidinopropane) dihydrochloride in 10 g of distilled water was added to the resultant solution to initiate the polymerization reaction under heating in a water

bath maintained at 70 °C. After conducting the polymerization at 70 °C for 6 hours in nitrogen gas stream, the reaction mixture was cooled to room temperature and then neutralized by addition of 7.64 g of 48 wt. % aqueous sodium hydroxide solution and 400 g of distilled water (neutralization rate: 12 molar % based on acrylic acid). The solid content of the resultant polymer solution as determined with a Kett moisture meter was found to be 15.4 % and the weight-average molecular weight was 300,000.

Example 1

There were used cellulose acetate crimped fibers having a size of 2 denier, length and crimp number shown in Table 1.

The web was prepared by mixing the fibers according to the carding method, subjected to water-needling method under a water pressure of 30 kg/cm^2 and dried to form the web having a basis weight of 30 g/m^2.

An aqueous solution containing 3 % by weight of the binder prepared by the referential example 1 was applied to the web and dried by the printing method so as to obtain a non-woven fabric having a content of 6 % by weight of the binder.

The properties of the non-woven fabrics were examine by the methods described below to obtain the results given in Table 1.

(1) Feeling (softness)

The feeling of the non-woven fabric was evaluated by an organoleptic test and the results were classified into the following three grades:

- ○: soft,
- △: slightly hard (tense), and
- X: hard (stiff).

(2) Dry strength:

The non-woven fabric was cut to pieces of a size of 2.5 cm x 9 cm. The samples thus obtained were tested with a tensile strength tester (Model GAC-100 by Toyo Boldwin Co. Ltd.) at a chuck distance of 5 cm and a stress rate of 100 mm/min.

(3) Wet strength:

The samples 2.5 cm x 9 cm prepared as described above were immersed in the following artificial urine for 1 minute, taken out therefrom and then dehydrated with a filter paper to a pickup of 150 % by weight. The samples thus treated were tested in the same manner as that of the above-described dry strength test.

Formulation of the artificial urine

urea 2.0 wt %; NaCl 1.0 wt %; $CaCl_2$ 0.1 wt %; $MgCl_2$ 0.07 wt %; and a balance of water

(4) Water dispersibility:

500 ml solution prepared by diluting the artificial urine 200 times with tap water and a piece of the non-woven fabric having a size of 6 cm x 6 cm were put in a 1000 ml cylindrical vessel with a lid. The vessel was placed in a shaker and shaken at 300 stroke per min. The degree of breakage of the non-woven fabric and dispersion thereof in the solution were determined.

- 3: almost complete dispersion,
- 2: somewhat insufficient dispersion,
- 1: no dispersion.

Table 1

Non-woven fabric No.	1	2	3*	4*	5*	6	7*
Fiber 1 length 15 mm crimp n. 7						35	100
Fiber 2 length 15 mm crimp n. 15	90wt%	40	90				
Fiber 3 length 15 mm crimp n. 21	10wt%	60			35	60	
Fiber 4 length 15 mm crimp n. 30					65	5	
Fiber 5 length 35 mm crimp n. 7				50			
Fiber 6 length 35 mm crimp n. 21			10	50			
Feeling	O	O	O	O	O	O	Δ
Dry strength (g)	870	960	900	1060	930	920	500
Wet strength (g)	380	410	390	450	370	350	180
Water dispersibility	3	3	1	1	1	3	3
Note: crimp n. means crimp number/inch							

* shows comparative examples.

As is apparent from Table 1, since the length of the fibers used in the preparation of non-woven fabric Nos. 3 and 4 is too long, the dispersibility thereof is not sufficient, and non-woven fabric No. 5 is also insufficient in terms of dispersibility since the amount of fiber 4 having a high crimp number is too large. The non-woven fabric No. 7 is insufficient in terms of mechanical strength and feeling since the fabric is composed of only fiber 1 having less crimp number. On the other hand, non-woven fabric Nos. 1, 2 and 6 of the present invention are of good properties.

Example 2

The web having a basis weight of 30 g/m^2 was prepared by the same method as in Example 1 except that rayon fibers having a size of 2 denier were used. An aqueous solution containing the binder used in Example 1 was applied to the web and dried so as to obtain a non-woven fabric having a basis weight of about 33 g/m^2. In this respect, the application of the solution was conducted by a printing method (P), spray method (S) or dripping method (D).

The properties of the resulting non-woven fabrics were determined by the same method in Example 1 and the results are shown in Table 2.

Table 2

Non-woven fabric No.	1	2*	3	4*	5	6
Fiber 7 length 15 mm crimp n. 7	70wt%	35	70	70	50	70
Fiber 8 length 15 mm crimp n. 23	30wt%	65	30	30	50	30
Application of binder solution	P	P	S	S	D	D
Binder content in the non-woven fabric	6wt%	6	30	35	20	6
Feeling	O	O	O	X	O	O
Dry strength (g)	850	910	860	1050	1180	900
Wet strength (g)	370	380	320	380	410	400
Water dispersibility	3	1	3	2	3	3
Note: crimp n. means crimp number/inch						

* shows comparative examples.

As shown in Table 2, non-woven fabric No. 4 is inferior in terms of feeling since the content of the binder in the fabric is high.

Example 3

Rayon fibers (3 denier; length: 10 mm) and water-soluble vinyl alcohol fibers (3 denier; length: 3 mm) were dispersed in water to a fiber concentration of 0.05 % by weight with a TAPPI test paper machine and then scooped with a screen to obtain a wet fiber sheet having a dry basis weight of 30 g/m^2. The sheet was pressed through a felt to squeeze cut water from it and dried at a temperature of 90 °C so as to make the vinyl alcohol fibers melt. The resulting sheet was then placed on a 80-mesh plain-weave metal gauze and water-needed with a water needling tester under a water pressure of 30 kg/cm^2.

5 weight % aqueous solution of binder of referential Example 2 was sprayed over the front and back surfaces of the sheet in an each amount of 5 % by weight. After drying with a hot dryer, a water-decomposable non-woven fabric was obtained.

The properties of the resulting non-woven fabrics were determined by the same method in Example 1 and the results are shown in Table 3.

Table 3

Non-woven fabric No.	1	2*
Rayon 1 length 10 mm crimp n. 7	70wt%	95wt%
Rayon 2 length 10 mm crimp n. 21	25wt%	0
PVA length 3 mm crimp n. 5	5wt%	5
Basis weight	33	33
Feeling	○	△
Dry strength (g)	1050	890
Wet strength (g)	310	130
Water dispersibility	3	3
Note: crimp n. means crimp number/inch		

* shows comparative example.

As shown in Table 3, even though the length of the fibers for non-woven fabric No. 1 of the present invention is short as 10 mm, the non-woven fabric could be prepared by a wet method, having good mechanical strength and feeling which are the same as those of the non-woven fabrics of the present invention in Examples 1 and 2. However, since the non-woven fabric No. 2 of the comparative example is composed of a large amount of fibers of crimp number of less than 7/inch, the fabric is practically unsatisfactory in terms of wet strength and feeling.

Claims

1. A water-decomposable non-woven fabric comprising a water-dispersible fiber layer, each fiber of which is bound with one another using a water-soluble binder comprising an unsaturated carboxylic acid/unsaturated carboxylic acid ester copolymer in which 1 to 60 mole % of the repeating units derived from the unsaturated carboxylic acid is in the form of a salt and which is soluble in tap water but is insoluble in an aqueous solution containing not less than 0.5 % by weight of a neutral inorganic salt comprising a monovalent ion; the water-dispersible fiber layer being composed of a mixture of 40 to 90 % by weight of fibers having a crimp number of 19/inch or less, 10 to 60 % by weight of fibers having a crimp number of 20/inch to 25/inch, and not more than 10 % by weight of fibers having a crimp number of 26/inch or more; and a content of the binder in the non-woven fabric being 1 to 30 % by weight relative to the total weight of the non-woven fabric.

2. The water-decomposable non-woven fabric of claim 1 wherein the water-dispersible fiber layer is composed of a mixture of 40 to 90 % by weight of fibers having a crimp number of 5/inch to 19/inch, 10 to 60% by weight of fibers having a crimp number of 20/inch to 25/inch, and not more than 10 % by weight of fibers having a crimp number of 26/inch to 30/inch.

3. The water-decomposable non-woven fabric of claim 1 wherein the water-dispersible fiber layer is composed of a mixture of 60 to 70 % by weight of fibers having a crimp number of 19/inch or less, 30 to 40 % by weight of fibers having a crimp number of 20/inch to 25/inch, and not more than 5 % by

weight of fibers having a crimp number of 26/inch or more.

4. The water-decomposable non-woven fabric of claim 3 wherein the water-dispersible fiber layer is composed of a mixture of 60 to 70 % by weight of fibers having a crimp number of 5/inch to 19/inch, 30 to 40 % by weight of fibers having a crimp number of 20/inch to 25/inch, and not more than 5 % by weight of fibers having a crimp number of 26/inch to 30/inch.

5. The water-decomposable non-woven fabric of claim 1 wherein the water-dispersible fiber layer is composed of a mixture of 40 to 90 % by weight of fibers having a crimp number of 5/inch to 19/inch and 10 to 60 % by weight of fibers having a crimp number of 20/inch to 25/inch.

6. The water-decomposable non-woven fabric of claim 1 wherein the fibers have a length of not longer than 30 mm.

7. The water-decomposable non-woven fabric of anyone of claims 1 to 6 wherein the fibers have a length of 5 to 30 mm.

8. A water-decomposable non-woven fabric comprising a water-dispersible fiber layer, each fiber of which is bound with one another using a water-soluble binder comprising an unsaturated carboxylic acid/unsaturated carboxylic acid ester copolymer in which 1 to 60 mole % of the repeating units derived from the unsaturated carboxylic acid is in the form of a salt and which is soluble in tap water but is insoluble in an aqueous solution containing not less than 0.5 % by weight of a neutral inorganic salt comprising a monovalent ion; the water-dispersible fiber layer being composed of a mixture of 40 to 90 % by weight of fibers having a crimp number of 5/inch to 19/inch and 10 to 60 % by weight of fibers having a crimp number of 20/inch to 25/inch; the fibers having a length of 5 to 30 mm; a content of the binder in the non-woven fabric being 2 to 20% by weight relative to the total weight of the non-woven fabric; and the fabric having a basis weight of 15 to 50 g/m^2.

9. The water-decomposable non-woven fabric of anyone of claims 1 to 8 wherein the water-soluble binder is a copolymer of 10 to 90 % by weight of acrylic acid and/or methacrylic acid and 90 to 10 % by weight of acrylic esters and/or methacrylic esters having an alkyl group of 1 to 18 carbon atoms or a cycloalkyl group of 3 to 18 carbon atoms in which 2 to 60 mole % of the repeating units derived from acrylic acid and/or methacrylic acid is in the form of a salt.

10. The water-decomposable non-woven fabric of claim 9 wherein the water-soluble binder is a copolymer of 20 to 70 % weight of acrylic acid and/or methacrylic acid and 80 to 30 % by weight of acrylic esters and/or methacrylic esters having an alkyl group of 1 to 18 carbon atoms or a cycloalkyl groups of 3 to 18 carbon atoms in which 5 to 50 mole % of the repeating units derived from acrylic acid and/or methacrylic acid is in the form of a salt.

11. The water-decomposable non-woven fabric of anyone of claims 1 to 8 wherein the water-soluble binder is a copolymer of 30 to 75 % by weight of acrylic acid, 5 to 30 % by weight of acrylic esters and/or methacrylic esters having an alkyl group of 8 to 12 carbon atoms and 20 to 40 % by weight of acrylic esters and/or methacrylic esters having an alkyl group of 2 to 4 carbon atoms in which 1 to 50 mole % of the repeating units derived from acrylic acid is in the form of a salt.

12. The water-decomposable non-woven fabric of anyone of claims 1 to 11 wherein the content of the binder in the non-woven fabric is 2 to 20 % by weight relative to the total weight of the non-woven fabric.

13. The water-decomposable non-woven fabric of anyone of claims 1 to 12 wherein the fabric has a basis weight of 15 to 50 g/m^2.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	PATENT ABSTRACTS OF JAPAN vol. 014, no. 143 (C-0703)19 March 1990 & JP-A-20 14 058 (HIROYUKI KANAI) 18 January 1990 * abstract * ---	1,8	D04H1/64 D04H1/42
Y	PATENT ABSTRACTS OF JAPAN vol. 014, no. 100 (C-0693)23 February 1990 & JP-A-13 06 661 (LION CORP) 11 December 1989 * abstract * ---	1	
Y A	WO-A-9 215 742 (H.B.FULLER LICENSING) * abstract; claims; examples * ---	8 2,9-11	
A	DATABASE WPI Section Ch, Week 3691, Derwent Publications Ltd., London, GB; Class A96, AN 91-264063 & JP-A-3 174 417 (LION CORP) 29 July 1991 * abstract * ---	1-7	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	DATABASE WPI Section Ch, Week 4991, Derwent Publications Ltd., London, GB; Class A14, AN 91-357893 & JP-A-3 239 709 (LION CORP) 25 October 1991 * abstract * ---	9-11	D04H
A	DATABASE WPI Section Ch, Week 2988, Derwent Publications Ltd., London, GB; Class A14, AN 88-202052 & JP-A-63 139 906 (LION CORP) 11 June 1988 * abstract * --- -/--	9-11	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	06 OCTOBER 1993	DURAND F.C.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	EP-A-0 326 298 (UNION OIL) * abstract; claims *	1	
A	DATABASE WPI Section Ch, Week 3183, Derwent Publications Ltd., London, GB; Class A82, AN 83-725249 & JP-A-58 104 902 (YUKA BADISCHE KK) 22 June 1983 * abstract *	1-6	
A	PATENT ABSTRACTS OF JAPAN vol. 014, no. 143 (C-0703)19 March 1990 & JP-A-20 14 007 (HIROYUKI KANAI) 18 January 1990 * abstract *	1-5,8-12	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	06 OCTOBER 1993	DURAND F.C.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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(54) Water-decomposable non-woven fabric

In Wasser abbaubares Vlies

Non-tissé décomposable dans l'eau

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Description

The present invention relates to a water-decomposable non-woven fabric which can be easily broken and dispersed by throwing into a large amount of water.

Non-woven fabrics have been widely used as a material for disposable absorbent articles such as sanitary napkins and paper diapers.

The non-woven fabrics used for the absorbent articles must have a toughness sufficient for resisting to breakage when they are wetted with a body fluid such as the menstrual blood or urine. Therefore, water-insoluble resins are generally used as a binder to bind fibers.

On the other hand, it is required of the non-woven fabrics to be used for the disposable absorbent articles or diaper liners that they can be brought into fine pieces and dispersed in water (water-decomposability) so that they can be thrown into a flush toilet. The above-described non-woven fabrics using water-insoluble resins as a binder are, therefore, unsatisfactory in view of these uses.

So far several proposals have been made on the water-decomposable non-woven fabric. For example, Japanese Patent Unexamined Published Application (hereinafter referred to as "J.P. KOKAI") No. Hei 1-306661 discloses a water-decomposable non-woven fabric comprising a water-decomposable fabric layer, each of faber of which is bound with one another using a water-soluble binder mainly containing an unsaturated carboxylic acid/unsaturated carboxylic acid ester copolymer in which a part of the unsaturated carboxylic acid is neutralized to form a salt. In this case, a fiber web is prepared from viscose rayon fibers having a length of 26 mm and a size of 2 denier by airlay method. However, since the viscose rayon fibers employed are of ordinal crimp numbers, i.e., not more than 19/25.4 mm (inch), the resulting water-decomposable non-woven fabric has weak mechanical strength. The content of binder in the non-woven fabric was increased in order to increase the mechanical strength, but the resulting non-woven fabric became hard and sufficient mechanical strength could not be obtained, which properties were still unsatisfactory in the practical view points.

JP-A-3 174 417 (Derwent abstract) relates to a water-soluble and salt-sensitive polymer which comprises (meth) acrylic acid and vinyl monomers. The polymer is soluble in fresh water but insoluble in water containing at least 5 % neutral inorganic salt of a monovalent ion. It is formed into film or a salt binder free from tackiness.

A primary object of the present invention is to provide a non-woven fabric having a good feeling (high softness and good touch), sufficient mechanical strength and water-decomposability by which the above-described problems in the prior art have been solved.

This and other objects of the present invention will be apparent from the following description and Examples.

The above-described problems can be solved by using a mixture of specific crimped fibres as a fabric layer of which non-woven fabric is composed.

Namely, the present invention provides a water-decomposable non-woven fabric comprising a water-dispersible fiber layer, each fiber of which is bound with one another using a water-soluble binder comprising an unsaturated carboxylic acid/unsaturated carboxylic acid ester copolymer in which 1 to 60 mole % of the repeating units derived from the unsaturated carboxylic acid is in the form of a salt and which is soluble in tap water but is insoluble in an aqueous solution containing not less than 0.5 % by weight of a neutral inorganic salt comprising a monovalent ion; the water-dispersible fiber layer being composed of a mixture of 40 to 90 % by weight of fibers having a crimp number of 19/25.4 mm (inch) or less, 10 to 60 % by weight of fibers having a crimp number of 20/25.4 mm (inch) to 25/25.4 mm (inch), and not more than 10 % by weight of fibers having a crimp number of 26/25.4 mm (inch) or more, wherein the crimped fibers have a length of not longer than 30 mm ; and the content of the binder in the non-woven fabric being 1 to 30 % by weight relative to the total weight of the non-woven fabric.

As fibers which compose the water-dispersible fiber layer (also referred to as web), there can be used conventional ones such as natural fibers (e.g. cotton, flax, jute, cotton linter and wooden pulp), regenerated cellulose fibers (e.g. rayon and cupro-ammonium rayon), modified cellulose fibers (e.g. cellulose acetate) and synthetic fibers (e.g. polyvinylalcohol, polyesters, polyamides and polyolefins). Although these fibers can be used singly or in combination, it is advantageous to use natural fibers or cellulose fibers in view of their biodegradability.

The web used in the present invention consists of a mixture of crimped fibers having a length or not longer than 30 mm. In this connection, the length of the fiber means a length when the crimped fiber is stretched in straight line. In other words, the length indicates a length of fiber which has not been crimped. The mixture comprises 40 to 90 % by weight of fibers having a crimp number of 19/25.4 mm (inch) or less, 10 to 60 % by weight of fibers having a crimp number of 20/25.4 mm (inch) to 25/25.4 mm (inch), and not more than 10 % by weight of fibers having a crimp number of 26/25.4 mm (inch) or more, preferably 60 to 70 % by weight of fibers having a crimp number of 19/25.4 mm (inch) or less, 30 to 40 % by weight of fibers having a crimp number of 20/25.4 mm (inch) to 25/25.4 mm (inch), and not more than 5 % by weight of fibers having a crimp number of 26/25.4 mm (inch) or more.

The crimped fibers can be easily prepared by a conventional method and the crimp number thereof can be easily arranged to appropriate numbers by controlling the condition of the preparation. For example, the fibers such as mod-

ified cellulose fibers and synthetic fibers can be mechanically crimped by a crimper and the crimp number can be controlled by changing the pressure of the crimper. Further, regarding regenerated cellulose fibers such as rayon, structural anisotropy is given to fibers in the direction of the size (width) of the fiber at spinning, cut into short fibers having a certain length, and heated so as to crimp the fibers due to the difference in the heat shrinkage. In this respect, the crimp number can be controlled by changing the structural anisotropy and heating condition such as a temperature and time period.

Where fibers having a length of longer than 30 mm are used and the resulting non-woven fabric is water-decomposed in water, there is observed phenomena in which so-called twined rope is formed by twisting the released fibers with one another. The resulting rope of fibers is of worse flowability and it is difficult to dispose it through a flush toilet. Therefore, it is preferable that the length of fibers used in the present invention be not longer than 30 mm, more preferably not longer than 20 mm. On the other hand, it is preferable that the length of fibers be not shorter than 5 mm in view of the preparation of the web.

The maximum crimp number of fibers is preferably not more than 30/25.4 mm (inch). Where the crimp number is over 30/25.4 mm (inch), it tends to easily form a rope of fibers. The minimum crimp number of fibers is preferably not less than 5/25.4 mm (inch). Where the crimp number is less than 5/25.4 mm (inch), the mechanical strength of the resulting web lowers. It is further preferable to use a mixture of 40 to 90 % by weight of fibers having a crimp number of 5/25.4 mm (inch) to 19/25.4 mm (inch) and 10 to 60 % by weight of fibers having a crimp number of 20/25.4 mm (inch) to 25/25.4 mm (inch).

The web can be prepared by either so-called wet method according to wet paper-making method or so-called dry method according to airlay method or carding method, but the wet method is preferable in view of the resulting web having high softness and good touch. In this connection, the web can be easily prepared even by a conventional carding method (dry method) since the present invention uses a mixture of the fibers comprising, as a main ingredient, crimped fibers having a crimp number of not more than 25/25.4 mm (inch). It is generally believed that it is difficult to prepare a web by a carding method using short fibers of a length of not longer than 50 mm, but the web can be easily prepared from the fibers since the fibers have specific crimp number. The web used as a raw material in the present Invention is preferably subjected to water-needling treatment. In this respect, since the specific crimped fibers are used, the water-needling treatment can be easily conducted even under a water pressure of 60 kg/cm^2 or lower and non-woven fabric having high softness and good touch can be prepared.

The binders usable in the invention to bind fibers are water-soluble unsaturated carboxylic acid/unsaturated carboxylic acid ester copolymers in which a part of the unsaturated carboxylic acid is neutralized to form a salt and which are soluble in tap water but are insoluble in an aqueous solution containing not less than 0.5 % by weight of a neutral inorganic salt comprising a monovalent ion such as NaCl, KCl or NaBr. Although conventional unsaturated carboxylic acids can be used as a monomer component of the copolymers, acrylic acid and/or methacrylic acid are preferable. Examples of the unsaturated carboxylic acid ester monomer components inciude acrylic esters and/or methacrylic esters having an alkyl group of 1 to 18 carbon atoms or a cycloalkyl group of 3 to 18 carbon atoms and it is preferable that acrylic esters and/or methacrylic esters having an aikyl group of 1 to 12 carbon atoms or a cycloalkyl groups of 3 to 12 carbon atoms be used singly or in combination.

More specifically, examples of the copolymers include copolymers of 10 to 90 %, preferably 20 to 70 % by weight of acrylic acid and/or methacrylic acid and 90 to 10 % preferably 80 to 30 % by weight of acrylic esters and/or methacrylic esters having an alkyl group of 1 to 18 carbon atoms or a cycloalkyl group of 3 to 18 carbon atoms in which 2 to 60 mole %, preferably 5 to 50 mole % of acrylic acid and/or methacryclic acid is neutralized to form a salt; or copolymers of 30 to 75 %, preferably 40 to 65 % by weight of acrylic acid, 5 to 30 %, preferably 10 to 25 % by weight of acrylic esters and/or methacrylic esters having an alkyl group of 8 to 12 carbon atoms and 20 to 40 %, preferably 25 to 35 % by weight of acrylic esters and/or methacrylic esters having an alkyl group of 2 to 4 carbon atoms in which 1 to 50 mole %, preferably 2 to 40 mole % of acrylic acid is neutralized to form a salt.

Where the amount of acrylic acid and/or methacrylic acid is larger than the amount mentioned above, strength of the resulting non-woven fabric against body fluids lowers. On the other hand, where the amount of acrylic acid and/or methacrylic acid is smaller than the amount mentioned above, water-solubility of the resulting polymer is reduced. Furthermore, where the neutralized ratio of the unsaturated carboxylic acid is larger than the ratio mentioned above, strength of the resulting non-woven fabric against body fluids lowers. Alternatively, where the neutralized ration is smaller than the ratio mentioned above, water-solubility of the resulting polymer is reduced. The molecular weight of the copolymers is not particularly limited, although the weight-average molecular weight of the copolymers is preferably 5,000 to 1,000,000, more preferably 30,000 to 500,000.

Any inorganic base or organic base can be optionally used as a neutralizing agent to neutralize the unsaturated carboxylic acid component of the copolymers. Examples of the neutralizing agents include inorganic bases such as sodium hydroxide, potassium hydroxide, lithium hydroxide and sodium carbonate, and amines such as monoethanolamine, diethanolamine, diethylaminoethanol, ammonia, trimethylamine, triethylamine, tripropylamine, morpholine. Preferred are ethanolamines or sodium hydroxide or a combination of potassium hydroxide and ethanolamines.

The water-soluble binders mentioned above can be used singly on in combination with an appropriate amount (preferably not more than 20 % by weight relative to total weight of binders) of other water-soluble polymers such as polyvinyl alcohol, polymers of acrylic acid, methacrylic acid or a salt thereof and carboxymethylcellulose.

The binder may be used in such that the non-woven fabric contains 1 to 30 %, preferably 2 to 20 % by weight of the binder. Where the amount of the binder is less than the amount mentioned above, the resulting non-woven fabric is practically insufficient in view of the mechanical strength. Alternatively, where the amount of the binder is more than the amount mentioned above, the resulting non-woven fabric does not have high softness and good touch.

The binder can be applied to the web by, for example, a spray method, dipping method, printing method or coating method. When the binder is applied to the web, it is possible to uniformly disperse the binder in all area of the web or to disperse in the form of spot. In this respect, it is preferable that some parts in the web remain unbound since the unbound parts work to easily absorb water immersed in the non-woven fabric and to disperse the fabric into each fiber in a short period of time.

Further, absorption and permiability of the non-woven fabric to body fluids can be improved by use of a natural surfactant mild to the skin such as sugar esters, glycerin succinates, alkyl polyglucosides and alkylglycoside acyl esters in combination with the binder at applying the binder to the web.

Although the basis weight of the non-woven fabric of the present invention is not particularly limited, the basis weight is desirably in the range of 15 to 50 g/m^2 which is usually considered to be low.

Even when the non-woven fabric of the present invention is brought into contact with a body fluid such as blood, menstrual blood or urine and wetted with it, the binder is not dissolved therein, since the salt concentration of the body fluid Is above the level of dissolution, and the structure of the non-woven fabric is kept to exhibit a toughness and softness satisfactory for the practical use. On the contrary, when the non-woven fabric is brought into contact with water, e.g., tap water, the binder is dissolved, since the salt concentration is reduced to a level low enough for the dissolution of the binder; and the non-woven fabric is easily broken and dispersed in water. Thus the non-woven fabric of the present invention can be disposed through a flush toilet.

The non-woven fabric of the present invention is useful as a surface material or wrapping material for various absorbent articles for absorbing body fluids such as sanitary napkins, sheets for a discharge from the womb, paper diapers and pads for hemorrhoids, or as materials for disposable non-woven fabric products such as bed sheets, toilet sheets for pets and diaper liners which can be disposed through a flush toilet after the use.

The present invention will be illustrated with reference to the following Examples.

Referential Example 1

47 g of acrylic acid, 53 g of cyclohexyl acrylate, 80 g of ethanol and 50 g of distilled water were fed in a 1000 ml four-necked separable flask provided with a stirrer, reflux condenser and nitrogen-introducing tube to obtain a homogeneous solution. Then nitrogen gas was introduced into the flask through the nitrogen-introducing tube under stirring. 20 minutes after, a solution of a polymerization Initiator prepared by dissolving 0.25 g of 2,2'-azobis(2,4-dimethylvaleronitrile) in 20 g of ethanol was added to the resultant solution to initiate the polymerization reaction under heating in a water bath maintained at 80 °C. After conducting the polymerization at 80 °C for 6 hours in nitrogen gas stream, the reaction mixture was cooled to room temperature and then neutralized by addition of 24.5 g of 48 wt. % aqueous sodium hydroxide solution and 380 g of distilled water (neutralization rate: 45 molar % based on acrylic acid). The solid content of the resultant polymer solution as determined with a Kett moisture meter was found to be 18.3 % and the weight-average molecular weight was 32,000.

Referential Example 2

55 g of acrylic acid, 15 g of 2-ethylhexyl acrylate, 30 g of butyl acrylate, 110 g of acetone and 30 g of distilled water were fed in a 1000 ml four-necked separable flask provided with a stirrer, reflux condenser and nitrogen-introducing tube to obtain a homogeneous solution. Then nitrogen gas was introduced into the flask through the nitrogen-introducing tube under stirring. 20 minutes after, a solution of a polymerization initiator prepared by dissolving 0.88 g of 2,2'-azobis(2-amidinopropane) dihydrochloride in 10 g of distilled water was added to the resultant solution to initiate the polymerization reaction under heating in a water bath maintained at 70°C. After conducting the polymerization at 70 °C for 6 hours in nitrogen gas stream, the reaction mixture was cooled to room temperature and then neutralized by addition of 7.64 g of 48 wt. % aqueous sodium hydroxide solution and 400 g of distilled water (neutralization rate: 12 molar % based on acrylic acid). The solid content of the resultant polymer solution as determined with a Kett moisture meter was found to be 15.4 % and the weight-average molecular weight was 300,000.

Example 1

There were used cellulose acetate crimped fibers having a size of 2 denier, length and crimp number shown in Table 1.

The web was prepared by mixing the fibers according to the carding method, subjected to water-needling method under a water pressure of 30 kg/cm^2 and dried to form the web having a basis weight of 30 g/m^2.

An aqueous solution containing 3 % by weight of the binder prepared by the referential example 1 was applied to the web and dried by the printing method so as to obtain a non-woven fabric having a content of 6 % by weight of the binder.

The properties of the non-woven fabrics were examined by the methods described below to obtain the results given In Table 1.

(1) Feeling (softness)

The feeling of the non-woven fabric was evaluated by an organoleptic test and the results were classified into the following three grades:

O: soft,
Δ: slightly hard (tense), and
×: hard (stiff).

(2) Dry strength:

The non-woven fabric was cut to pieces of a size of 2.5 cm x 9 cm. The samples thus obtained were tested with a tensile strength tester (Model GAC-100 by Toyo Boldwin Co. Ltd.) at a chuck distance of 5 cm and a stress rate of 100 mm/min.

(3) Wet strength:

The samples 2.5 cm x 9 cm prepared as described above were immersed in the following artificial urine for minute, taken out therefrom and then dehydrated with a filter paper to a pickup of 150 % by weight. The samples thus treated were tested in the same manner as that of the above-described dry strength test.

Formulation of the artificial urine

urea 2.0 ut %; NaCl 1.0 wt %; $CaCl_2$ 0.1 wt %; $MgCl_2$ 0.07 wt %; and a balance of water

(4) Water dispersibility:

500 ml solution prepared by diluting the artificial urine 200 times with tap water and a piece of the non-woven fabric having a size of 6 cm x 6 cm were put in a 1000 ml cylindrical vessel with a lid. The vessel was placed in a shaker and shaken at 300 stroke per min. The degree of breakage of the non-woven fabric and dispersion thereof in the solution were determined.

3: almost complete dispersion,
2: somewhat insufficient dispersion,
1: no dispersion.

Table 1

Non-woven fabric No.	1	2	3*	4*	5*	6	7*
Fiber 1 length 15 mm crimp n. 7						35	100
Fiber 2 length 15 mm crimp n. 15	90wt%	40	90				
Fiber 3 length 15 mm crimp n. 21	10wt%	60			35	60	

Note: crimp n. means crimp number/25.4 mm (inch)
* shows comparative examples.

Table 1 (continued)

Non-woven fabric No.	1	2	3*	4*	5*	6	7*
Fiber 4 length 15 mm crimp n. 30					65	5	
Fiber 5 length 35 mm crimp n. 7				50			
Fiber 6 length 35 mm crimp n. 21			10	50			
Feeling	○	○	○	○	○	○	△
Dry strength (g)	870	960	900	1060	930	920	500
Wet strength (g)	380	410	390	450	370	350	180
Water dispersibility	3	3	1	1	1	3	3

Note: crimp n. means crimp number/25.4 mm (inch)
* shows comparative examples.

As is apparent from Table 1, since the length of the fibers used in the preparation of non-woven fabric Nos. 3 and 4 is too long, the dispersibility thereof is not sufficient, and non-woven fabric No. 5 is also insufficient in terms of dispersibility since the amount of fiber 4 having a high crimp number is too large. The non-woven fabric No. 7 is insufficient in terms of mechanical strength and feeling since the fabric is composed of only fiber 1 having less crimp number. On the other hand, non-woven fabric Nos. 1, 2 and 6 of the present invention are of good properties.

Example 2

The web having a basis weight of 30 g/m^2 was prepared by the same method as in Example 1 except that rayon fibers having a size of 2 denier were used. An aqueous solution containing the binder used in Example 1 was applied to the web and dried so as to obtain a non-woven fabric having a basis weight of about 33 g/m^2. In this respect, the application of the solution was conducted by a printing method (P), spray method (S) or dipping method (D).

The properties of the resulting non-woven fabrics were determined by the same method in Example 1 and the results are shown in Table 2.

Table 2

Non-woven fabric No.	1	2*	3	4*	5	6
Fiber 7 length 15 mm crimp n. 7	70wt%	35	70	70	50	70
Fiber 8 length 15 mm crimp n. 23	30wt%	65	30	30	50	30
Application of binder solution	P	P	S	S	D	D
Binder content in the non-woven fabric	6wt%	6	30	35	20	6
Feeling	○	○	○	×	○	○
Dry strength (g)	850	910	860	1050	1180	900
Wet strength (g)	370	380	320	380	410	400
Water dispersibility	3	1	3	2	3	3

Note: crimp n. means crimp number/25.4 mm (inch)
* shows comparative examples.

As shown in Table 2, non-woven fabric No. 4 is inferior in terms of feeling since the content of binder in the fabric is high.

Example 3

Rayon fibers (3 denier; length: 10 mm) and water-soluble vinyl alcohol fibers (3 denier; length: 3 mm) were dispersed in water to a fiber concentration at 0.05 % by weight with a TAPPI test paper machine and then scooped with a screen to obtain a wet fiber sheet having a dry basis weight of 30 g/m^2. The sheet was pressed through a felt to squeeze out water from it and dried at a temperature of 90 °C so as to make the vinyl alcohol fibers melt. The resulting sheet was then placed on a 80-mesh plain-weave metal gauze and water-needled with a water needling tester under a water pressure of 30 kg/cm^2.

5 weight % aqueous solution of binder of referential Example 2 was sprayed over the front and back surfaces of the sheet in an each amount of 5 % by weight. After drying with a hot air dryer, a water-decomposable non-woven

fabric was obtained.

The properties of the resulting non-woven fabrics were determined by the same method in Example 1 and the results are shown in Table 3.

Table 3

Non-woven fabric No.	1	2*
Rayon 1 length 10 mm crimp n.7	70wt%	95wt%
Rayon 2 length 10 mm crimp n. 21	25wt%	0
PVA length 3 mm crimp n. 5	5wt%	5
Basis weight	33	33
Feeling	○	△
Dry strength (g)	1050	890
Wet strength (g)	310	130
Water dispersibility	3	3

Note: crimp n. means crimp numer 25.4 mm (inch)
* shows comparative example.

As shown in Table 3, even though the length of the fibers for non-woven fabric No. 1 of the present invention is short as 10 mm. the non-woven fabric could be prepared by a wet method, having good mechanical strength and feeling which are the same as those of the non-woven fabrics of the present invention in Examples 1 and 2. However, since the non-woven fabric No. 2 of the comparative example is composed of a large amount of fibers of crimp number of less than 7/25.4 mm (inch), the fabric is practically unsatisfactory in terms or web strength and feeling.

Claims

1. A water-decomposable non-woven fabric comprising a water-dispersible fiber layer, each fiber of which is bound with one another using a water-soluble binder comprising an unsaturated carboxylic acid/unsaturated carboxylic acid ester copolymer in which 1 to 60 mole % of the repeating units derived from the unsaturated carboxylic acid is in the form of a salt and which is soluble in tap water but is insoluble in an aqueous solution containing not less than 0.5 % by weight of a neutral inorganic salt comprising a monovalent ion; the water-dispersible fiber layer being composed of a mixture of 40 to 90 % by weight of fibers having a crimp number of 19/25.4 mm (inch) or less, 10 to 60 % by weight of fibers having a crimp number of 20/25.4 mm (inch) to 25/25.4 mm (inch), and not more than 10 % by weight of fibers having a crimp number of 26/25.4 mm (inch) or more, wherein the crimped fibers have a length of not longer than 30 mm; and the content of the binder in the non-woven fabric being 1 to 30 % by weight relative to the total weight of the non-woven fabric.

2. The water-decomposable non-woven fabric of claim 1 wherein 40 to 90 % by weight of the fibers have a crimp number of 5/25.4 mm (inch) to 19/25.4 mm (inch).

3. The water-decomposable non-woven fabric of claim 2 wherein not more than 10 % by weight of the fibers have a crimp number of 26/25.4 mm (inch) to 30/25.4 mm (inch).

4. The water-decomposable non-woven fabric of claim 1 wherein the water-dispersible fiber layer is composed of a mixture of 60 to 70 % by weight of fibers having a crimp number of 19/25.4 mm (inch) or less, 30 to 40 % by weight of fibers having a crimp number of 20/25.4 mm (inch) to 25/25.4 mm (inch), and not more than 5 % by weight of fibers having a crimp number of 26/25.4 mm (inch) or more.

5. The water-decomposable non-woven fabric of claim 4 wherein 60 to 70 % by weight of the fibers have a crimp number of 5/25.4 mm (inch) to 19/25.4 mm (inch) and not more than 5 % by weight of the fibers have a crimp number of 26/25.4 mm (inch) to 30/25.4 mm (inch).

6. The water-decomposable non-woven fabric of anyone of claims 1 to 5 wherein the fibers have a length of 5 to 30

mm.

7. The water-decomposable non-woven fabric of anyone of claims 1 to 6 wherein the water-soluble binder is a copolymer of 10 to 90 % by weight of acrylic acid and/or methacrylic acid and 90 to 10 % by weight of acrylic esters and/or methacrylic esters having an alkyl group of 1 to 18 carbon atoms or a cycloalkyl group or 3 to 18 carbon atoms in which 2 to 60 mole % of the repeating units derived from acrylic acid and/or methacrylic acid is in the form of a salt.

8. The water-decomposable non-woven fabric of claim 7 wherein the water-soluble binder is a copolymer of 20 to 70 % by weight of acrylic acid and/or methacrylic acid and 80 to 30 % by weight of acrylic esters and/or methacrylic esters having an alkyl group of 1 to 18 carbon atoms or a cycloalkyl group of 3 to 18 carbon atoms in which 5 to 50 mole % of the repeating units derived from acrylic acid and/or methacrylic acid is in the form of a salt.

9. The water-decomposable non-woven fabric of anyone of claims 1 to 6 wherein the water-soluble binder is a copolymer of 30 to 75 % by weight of acrylic acid, 5 to 30 %by weight of acrylic esters and/or methacrylic esters having an alkyl group of 8 to 12 carbon atoms and 20 to 40 % by weight of acrylic esters and/or methacrylic esters having an alkyl group of 2 to 4 carbon atoms in which 1 to 50 mole % of the repeating units derived from acrylic acid is in the form of a salt.

10. The water-decomposable non-woven fabric of anyone of claims 1 to 9, wherein the content of the binder in the non-woven fabric is 2 to 20 % by weight relative to the total weight of the non-woven fabric.

11. The water-decomposable non-woven fabric of anyone of claims 1 to 10 wherein the fabric has a basis weight of 15 to 50 g/m^2.

Patentansprüche

1. In Wasser abbaubares Vlies, umfassend eine in Wasser dispergierbare Faserschicht, wobei die Fasern davon untereinander unter Verwendung eines wasserlöslichen Bindemittels gebunden sind, das ein Copolymer aus ungesättigter Carbonsäure/ungesättigtem Carbonsäureester umfaßt, in dem 1 bis 60 Mol-% der von der ungesättigten Carbonsäure stammenden sich wiederholenden Einheiten in Form eines Salzes vorliegen, und das in Leitungswasser löslich ist, aber in einer wäßrigen Lösung, die nicht weniger als 0,5 Gewichts-% eines anorganischen, ein einwertiges Ion umfassenden Neutralsalzes enthält, unlöslich ist; wobei die in Wasser dispergierbare Faserschicht aus einem Gemisch aus 40 bis 90 Gewichts-% an Fasern mit einer Kräuselzahl von 19/25,4 mm (1 Zoll) oder weniger, 10 bis 60 Gewichts-% an Fasern mit einer Kräuselzahl von 20/25,4 mm (1 Zoll) bis 25/25,4 mm (1 Zoll), und nicht mehr als 10 Gewichts-% an Fasern mit einer Kräuselzahl von 26/25,4 mm (1 Zoll) oder mehr besteht, wobei die gekräuselten Fasern eine Länge von nicht größer als 30 mm aufweisen; und der Bindemittelgehalt im Vlies bezogen auf das Gesamtgewicht des Vlieses 1 bis 30 Gewichts-% beträgt.

2. In Wasser abbaubares Vlies nach Anspruch 1, wobei 40 bis 90 Gewichts-% der Fasern eine Kräuselzahl von 5/25,4 mm (1 Zoll) bis 19/25,4 mm (1 Zoll) aufweisen.

3. In Wasser abbaubares Vlies nach Anspruch 2, wobei nicht mehr als 10 Gewichts-% der Fasern eine Kräuselzahl von 26/25,4 mm (1 Zoll) bis 30/25,4 mm (1 Zoll) aufweisen.

4. In Wasser abbaubares Vlies nach Anspruch 1, wobei die in Wasser dispergierbare Faserschicht aus einem Gemisch aus 60 bis 70 Gewichts-% an Fasern mit einer Kräuselzahl von 19/25,4 mm (1 Zoll) oder weniger, 30 bis 40 Gewichts-% an Fasern mit einer Kräuselzahl von 20/25,4 mm (1 Zoll) bis 25/25,4 mm (1 Zoll) und nicht mehr als 5 Gewichts-% an Fasern mit einer Kräuselzahl von 26/25,4 mm (1 Zoll) oder mehr besteht.

5. In Wasser abbaubares Vlies nach Anspruch 4, wobei 60 bis 70 Gewichts-% der Fasern eine Kräuselzahl von 5/25,4 mm (1 Zoll) bis 19/25,4 mm (1 Zoll) und nicht mehr als 5 Gewichts-% der Fasern eine Kräuselzahl von 26/25,4 mm (1 Zoll) bis 30/25,4 mm (1 Zoll) aufweisen.

6. In Wasser abbaubares Vlies nach einem der Ansprüche 1 bis 5, wobei die Fasern eine Länge von 5 bis 30 mm haben.

7. In Wasser abbaubares Vlies nach einem der Ansprüche 1 bis 6, wobei das wasserlösliche Bindemittel ein Copolymer aus 10 bis 90 Gewichts-% Acrylsäure und/oder Methacrylsäure und 90 bis 10 Gewichts-% Acrylsäureestern und/oder Methacrylsäureestern mit einem Alkylrest mit 1 bis 18 Kohlenstoffatomen oder mit einem Cycloalkylrest mit 3 bis 18 Kohlenstoffatomen ist, in dem 2 bis 60 Mol-% der von der Acrylsäure und/oder Methacrylsäure stammenden sich wiederholenden Einheiten in Form eines Salzes vorliegen.

8. In Wasser abbaubares Vlies nach Anspruch 7, wobei das wasserlösliche Bindemittel ein Copolymer aus 20 bis 70 Gewichts-% Acrylsäure und/oder Methacrylsäure und 80 bis 30 Gewichts-% Acrylsäureestern und/oder Methacrylsäureestern mit einem Alkylrest mit 1 bis 18 Kohlenstoffatomen oder mit einem Cycloalkylrest mit 3 bis 18 Kohlenstoffatomen ist, in dem 5 bis 50 Mol-% der von der Acrylsäure und/oder Methacrylsäure stammenden sich wiederholenden Einheiten in Form eines Salzes vorliegen.

9. In Wasser abbaubares Vlies nach einem der Ansprüche 1 bis 6, wobei das wasserlösliche Bindemittel ein Copolymer aus 30 bis 75 Gewichts-% Acrylsäure, 5 bis 30 Gewichts-% Acrylsäureestern und/oder Methacrylsäureestern mit einem Alkylrest mit 8 bis 12 Kohlenstoffatomen, und 20 bis 40 Gewichts-% Acrylsäureestern und/oder Methacrylsäureestern mit einem Alkylrest mit 2 bis 4 Kohlenstoffatomen ist, in dem 1 bis 50 Mol-% der von der Acrylsäure stammenden sich wiederholenden Einheiten in Form eines Salzes vorliegen.

10. In Wasser abbaubares Vlies nach einem der Ansprüche 1 bis 9, wobei der Bindemittelgehalt im Vlies, bezogen auf das Gesamtgewicht des Vlieses, 2 bis 20 Gewichts-% beträgt.

11. In Wasser abbaubares Vlies nach einem der Ansprüche 1 bis 10, wobei das Vlies ein Basisgewicht von 15 bis 50 g/m^2 besitzt.

Revendications

1. Etoffe non tissée décomposable dans l'eau comprenant une couche de fibres pouvant être dispersée dans l'eau, dont chaque fibre est liée l'une à l'autre en utilisant un liant hydrosoluble comprenant un copolymère acide carboxylique insaturé/ester d'acide carboxylique insaturé dans lequel de 1 à 60 % en mole des unités répétées dérivées de l'acide carboxylique insaturé sont sous forme d'un sel et qui est soluble dans l'eau courante mais qui est insoluble dans une solution aqueuse ne contenant pas moins de 0,5 % en poids d'un sel minéral neutre comprenant un ion monovalent; la couche de fibres pouvant être dispersée dans l'eau étant composée d'un mélange de 40 à 90 % en poids de fibres ayant un nombre de crêpages de 19/25,4 mm (pouce) ou moins, 10 à 60 % en poids des fibres ayant un nombre de crêpages de 20/25,4 mm (pouce) à 25/25,4 mm (pouce), et pas plus de 10 % en poids des fibres ayant un nombre de crêpages de 26/25,4 mm (pouce) ou plus, les fibres crêpées ayant une longueur qui n'est pas supérieure à 30 mm ; et la teneur du liant dans l'étoffe non tissée étant de 1 à 30 % en poids par rapport au poids total de l'étoffe non tissée.

2. Etoffe non tissée décomposable dans l'eau selon la revendication 1, caractérisée en ce que 40 à 90 % en poids des fibres ont un nombre de crêpages de 5/25,4 mm (pouce) à 19/ 25,4 mm (pouce).

3. Etoffe non tissée décomposable dans l'eau selon la revendication 2, caractérisée en ce que pas plus de 10 % en poids des fibres ont un nombre de crêpages de 26/25,4 mm (pouce) à 30/ 25,4 mm (pouce).

4. Etoffe non tissée décomposable dans l'eau selon la revendication 1, caractérisée en ce que la couche de fibres pouvant être dispersée dans l'eau est un mélange de 60 à 70 % en poids de fibres ayant un nombre de crêpages de 19/25,4 mm (pouce) ou moins, 30 à 40 % en poids des fibres ont un nombre de crêpages de 20/25,4 mm (pouce) à 25/25,4 mm (pouce) et que pas plus de 5 % en poids de fibres ont un nombre de crêpages de 26/25,4 mm (pouce) ou plus.

5. Etoffe non tissée décomposable dans l'eau selon la revendication 4, caractérisée en ce que 60 à 70 % en poids des fibres ont un nombre de crêpages de 5/25,4 mm (pouce) à 19/25,4 mm (pouce) et que pas plus de 5 % en poids des fibres ont un nombre de crêpages de 26/25,4 mm (pouce) à 30/25,4 mm (pouce).

6. Etoffe non tissée décomposable dans l'eau selon l'une quelconque des revendications 1 à 5, caractérisée en ce que les fibres ont une longueur de 5 à 30 mm.

7. Etoffe non tissée décomposable dans l'eau selon l'une quelconque des revendications 1 à 6, caractérisée en ce que le liant hydrosoluble est un copolymère de 10 à 90 % en poids d'acide acrylique et/ou d'acide méthacrylique et de 90 à 10 % en poids d'esters acryliques et/ou d'esters méthacryliques ayant un groupe alkyle de 1 à 18 atomes de carbone ou un groupe cycloalkyle de 3 à 18 atomes de carbone dans lequel 2 à 60 % en moles des unités répétitives dérivées d'acide acrylique et/ou d'acide méthacrylique sont sous forme d'un sel.

8. Etoffe non tissée décomposable dans l'eau selon la revendication 7, caractérisée en ce que le liant hydrosoluble est un copolymère de 20 à 70 % en poids d'acide acrylique et/ou d'acide méthacrylique et de 80 à 30 % en poids d'esters acryliques et/ou d'esters méthacryliques ayant un groupe alkyle de 1 à 18 atomes de carbone ou un groupe cycloalkyle de 3 à 18 atomes de carbone dans lequel 5 à 50 % en moles des unités répétitives dérivées d'acide acrylique et/ou d'acide méthacrylique sont sous forme d'un sel.

9. Etoffe non tissée décomposable dans l'eau selon l'une quelconque des revendications 1 à 6, caractérisée en ce que le liant hydrosoluble est un copolymère de 30 à 75 % en poids d'acide acrylique, de 5 à 30 % en poids d'esters acryliques et/ou d'esters méthacryliques ayant un groupe alkyle de 8 à 12 atomes de carbone et de 20 à 40 % en poids d'esters acryliques et/ou d'esters méthacryliques ayant un groupe alkyle de 2 à 4 atomes de carbone dans lequel 1 à 50 % en moles des unités répétitives dérivées d'acide acrylique sont sous forme d'un sel.

10. Etoffe non tissée décomposable dans l'eau selon l'une quelconque des revendications 1 à 9, caractérisée en ce que le liant dans l'étoffe non tissée est 2 à 20 % en poids par rapport au poids total de l'étoffe non tissée.

11. Etoffe non tissée décomposable dans l'eau selon l'une quelconque des revendications 1 à 10, caractérisée en ce que l'étoffe a un grammage de 15 à 50 g/m^2.